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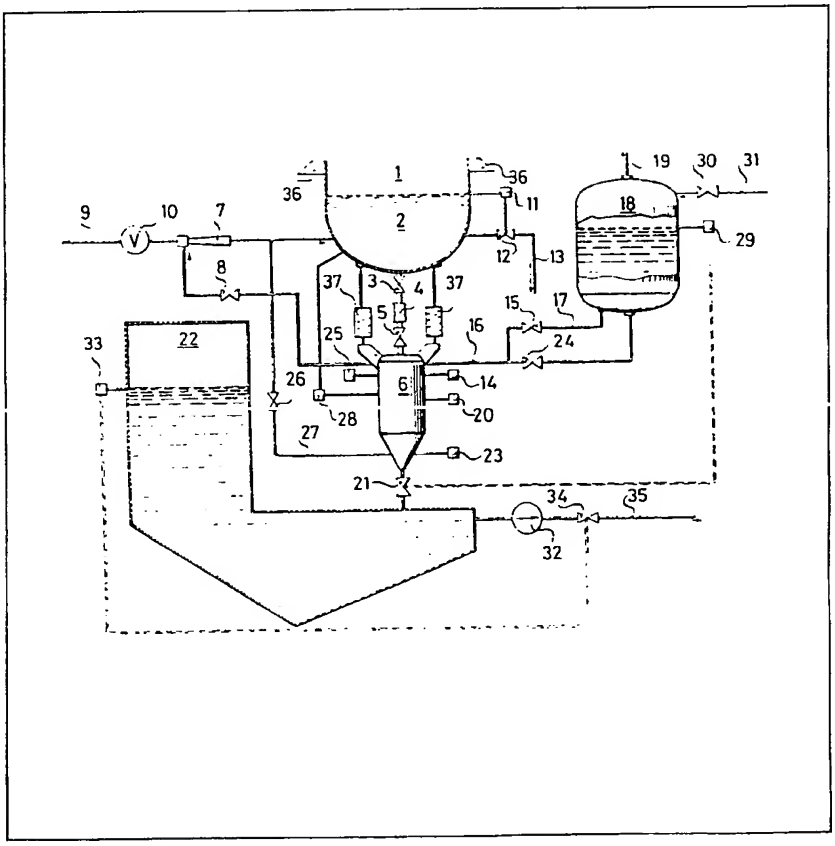
(54) **Sluicing of residues from the pressure system of a pressure gasification plant**

(57) Apparatus for periodically sluicing residues produced by gasifying ash-containing fuel with oxygen or one or more oxygen-containing compounds under pressure, comprises a gasification chamber (1) in communication with a water bath (2) in which the residues are granulated. The water bath is connected through a valve arrangement to a lock vessel (6) so that pressure equalization may be effected between the lock vessel (6) and the water bath to allow the residues to discharge from the water bath into the lock vessel. On closing the connection between the water bath and the lock vessel and opening a connection between the lock vessel and a surge tank (18), depressurization of the lock vessel is effected. On opening a connection between the lock vessel and a collecting vessel (22), residues pass from the lock vessel into the collecting vessel and water flows from the surge tank into the collecting vessel to flush suspended and granulated residues from the lock vessel into the collecting vessel.

The water level in the collecting vessel, when its connection with the lock vessel is open, is maintained sufficiently high to prevent gas entering the lock vessel from the collecting vessel.



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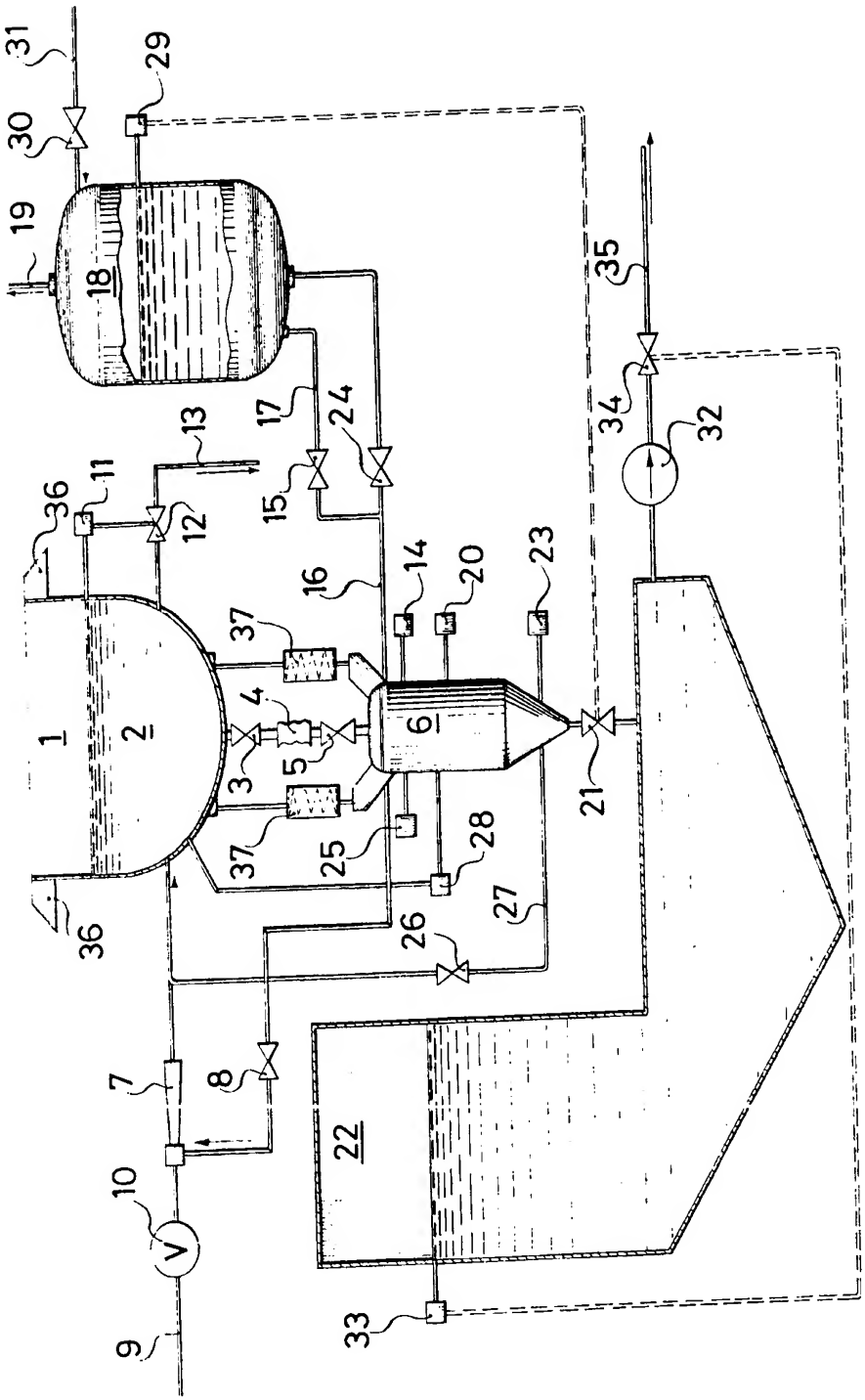
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SPECIFICATION

Sluicing of residues from the pressure system of a pressure gasification plant

The invention relates to the sluicing of residues produced by gasification of ash-containing fuels, especially solid fuels such as coal, brown coal, lignite and other carbon-containing substances, with oxygen or one or more oxygen-containing compounds such as water and/or carbon dioxide. The reaction of the feedstock (fuel) is carried out at a pressure of 10 to 200 bar. The gasification residues leave the gasification chamber in a liquid or plastic state and are converted, in a water bath connected to the gasification chamber, into a solid granulate, which may be fine grained. The granular residues are periodically discharged from the pressure system of the pressure gasification plant by means of a lock vessel filled with water and arranged beneath the water bath.

Processes and apparatus for sluicing the ash must meet a number of requirements. Apart from the fact that their operation must be possible with an economically justifiable expenses, it must be ensured that the sluicing of the residues is effected safely and without polluting the environment. Thus, it is absolutely necessary that escape of production gas from the gasification chamber, which stands under high pressure, into the atmosphere is avoided because of the risk of poisoning and explosion. Additionally, care has to be taken that hazardous gases or gases having an unpleasant odour which, for example, are dissolved in the process liquor under pressure and are liberated on depressurization as well as the waste water discharged with the slag do not enter the environment. Finally, the discharge of the granulated slag from the gasification chamber into the sluicing system should be interrupted only for a short time by the sluicing process to avoid backwash or damming up the slag in the gasification chamber and, consequently, blocking of the outlet.

A process for sluicing residues from a gasification chamber under elevated pressure is described in the West German Offenlegungsschrift (DE-OS) 24 55 127 and involves the use of a water bath for granulating the ash, a lock vessel and a conveyor. After closure of the connection between the water bath and the lock vessel, the latter is depressurized *via* a pressure equalization vessel which is connected with the lock vessel and which, while the connection between the water bath and the lock vessel was open, had the same water level and, by means of an inert gas pad, had also the same pressure as that in the water bath. While the lock vessel is empitied, inert gas under low pressure is introduced into the pressure equalization vessel and, after the lock vessel has been emptied and the connection between the lock vessel and the conveyor has been closed, the lock system is again filled up with water and then brought again to the pressure of the gasification chamber by introducing into the pressure equalization vessel an inert gas which is under a higher pressure than that of the gasification chamber.

It is one disadvantage of this prior art process that the lock vessel must be filled up again with water for each operating cycle. This procedure is relatively time-consuming and requires a complicated pressure equalization system with inert gas. Moreover, gases liberated from the water of the lock vessel on depressurization are not prevented from entering the atmosphere.

It is an object of the invention to avoid the disadvantages described above.

In accordance with the present invention there is provided a process for periodically sluicing residues produced by gasifying ash-containing fuel with oxygen or one or more oxygen-containing compounds under a pressure of 100 to 200 bar, the gasification being carried out in a gasification chamber and the residues being granulated in a water bath in communication with the gasification chamber, the process comprising: effecting pressure equalization between a lock vessel and the water bath and the lock vessel to allow the residues to discharge from the water bath through the connection into the lock vessel; closing the connection between the lock vessel and the water bath; opening a connection between the lock vessel and a surge tank to effect depressurization of the lock vessel and to effect removal of gases and steam *via* the surge tank to a closed gas system; opening a connection between the lock vessel and a collecting vessel to allow residues to pass from the lock vessel into the collecting vessel; and allowing water to flow from the surge tank into the collecting vessel to flush suspended and granulated residues from the lock vessel into the collecting vessel; maintaining the water level in the collecting vessel, when its connection with the lock vessel is open, sufficiently high to prevent gas entering the lock vessel from the collecting vessel; and removing the residues from the collecting vessel.

According to the present invention the lock vessel is constantly filled with water. Thus the lock vessel is filled with water when the connection between the lock vessel and the gasification chamber is closed and the granulated residues are discharged.

To maintain the lock vessel constantly filled with water, the lock vessel is connected to the surge tank, with is situated at a higher level and is filled with water, and to a collecting vessel, which is also filled with water and is at atmospheric pressure, so that, under normal conditions, neither gas nor steam are able to enter the lock vessel from the outside.

Sinking of the water level in the lock vessel, possibly due to gas or vapour being introduced, indicates malfunction of the lock system and may be utilized by measuring devices for actuating shutoff devices between the gasification chamber and the lock vessel.

The solid residues granulated in the water bath sink by gravity into the lock vessel during the filling of the lock vessel. Preferably residues of very fine-granular consistency are conveyed from the water bath into the lock vessel by means of an injector. The injector is operated using the water flowing into the water bath. The injector draws at least as much water from the lock vessel as is

displaced by the residues entering the lock vessel.

During the sluicing period, after opening a shutoff device located between the lock vessel and the collecting vessel, the granulated residues present in the lock vessel sink from the lock vessel into the collecting vessel either solely due to their higher specific gravity than water or are flushed by fresh water flowing into the lock vessel together with the water of the lock vessel into the surge tank by additional opening of a connecting pipe between the receiver and the lock vessel. It is of particular importance that, in the process according to the invention, the fresh water is passed from the surge tank into the lock vessel without gas or vapour being able to enter from the outside. The quantity of fresh water may be adjusted as desired by controlling the shut-off device between the surge tank and the lock vessel and by observing the water level in the surge tank. It is possible in this manner to assist the discharge of the residues from the lock vessel by a directed flushing action, to compensate for the water consumption in the collecting vessel and, moreover, to adjust the water in the lock vessel to a desired temperature.

Both clean tap water and cooled, purified and degassed recycled water from the scrubbing system of the gas produced in the gasification plant may be used as fresh water in the surge tank.

The surge tank is connected to a closed gas system which is maintained under constant, approximately atmospheric pressure or at slightly above atmospheric pressure.

The granulated residues which are periodically discharged from the lock vessel are passed into the water-filled collecting vessel which is operated at atmospheric pressure. The water level in this vessel is adjusted sufficiently high so that gas is unable to penetrate from below into the lock vessel and the lower-than-atmospheric pressure resulting in the upper part of the lock vessel does not become so high that the liquid column breaks, e.g. by formation of vapour. The granulated residues may be discharged from the collecting vessel in known manner either by means of mechanical conveyors (e.g. slag scrapers, bucket conveyors or sieve conveyor belt) or hydraulically. In the case of mechanical conveying, the amount of waste water is kept very small. When conveying hydraulically, the water is returned to the collecting vessel after settling of the residues.

In the collecting vessel, the different sedimentation behaviour of the residual particles is utilized to separate fine solids in the gasification residues, a substantial part of which fine solids consist of carbonaceous contituents which have not been burnt in the gasification reaction, from the larger slag particles which settle rapidly in the water and to recirculate them to the gasification process.

Apparatus for carrying out the process of the invention comprises: a gasification reactor providing a gasification chamber and a water bath immediately below the gasification chamber; means for supplying recycled water to the water bath; a lock vessel; means for opening and closing a connection between the water bath and the lock vessel; a collecting vessel; means for opening and closing a connection between the lock vessel and the collecting vessel; a surge tank; and means for opening and closing a connection between the lock vessel and the surge tank.

The lock vessel should preferably be of size that the number of discharge cycles per unit time need only be low in order to sluice the slag produced safely in the gasification chamber. Not more than 8 to 12 discharge cycles per hour are normally aimed at.

The dimensions of the surge tank and collecting vessel should be selected such that safe operation is ensured even at the lowest water level.

The lock vessel is desirably suspended at the pressure vessel surrounding the gasification chamber in such a manner that the thermal expansions of both vessels occurring both with respect to each other and jointly with respect to the surrounding supporting structure do not lead to damage. Therefore, all connections are preferably constructed elastically with compensators. As a safeguard against uncontrolled actions of forces on fittings and connecting pipes, due to the considerable weight of the pressure-bearing structural parts, by thermal expansion or by external forces, the lock vessel and the pressure vessel surrounding the gasification chamber are preferably connected flexibly so that the lock vessel may also be moved laterally. Additionally, the lock vessel may be connected to the pressure vessel by a spring suspension. In this manner the weight of all suspended parts is fully supported and, even when thermal expansions occur, does not act on the fittings. The lateral guidance of the lock vessel in the supporting structure is constructed such that vertical expansion movements are possible.

Side valves and, preferably, ball valves with a large free cross-sectional area are used as shutoff devices between the slag-containing vessles. The ball valves may be constructed with smooth walls without corners, edges and dead spaces. The slag granules suspended in water may pass through them unchecked. The balls and seating which are exposed to a particular high extent in the abrasive action of the slag are preferably provided with a wear-resistant armouring. The shut-off devices must also be suitable for operation at high water temperatures.

The driving mechanism of the shutoff devices is to be designed for the maximum differential pressure which may occur so that in case of trouble the shutoff devices are able to operate against the full gasification pressure. In normal sluicing operation, switching is effected almost at pressure balance.

For safety reasons, an additional shutoff device which is constantly open in normal sluicing operation is preferably provided directly beneath the gasification chamber. It is provided with a completely separate reliable driving system and automatically shuts the gasification chamber in case of trouble.

The invention is further described below by way of example with reference to the accompanying drawing, which diagramatically shows apparatus according to the invention.

The apparatus shown in the drawing comprises a

gasification reactor having a gasification chamber 1 and a water bath 2 immediately below the gasification chamber. The water bath 2 is supplied with recycle water through a line 9 and is connected through a flexible junction 4 and shutoff devices 3 and 5 with a lock vessel 6. The lock vessel 6 is connected *via* a shutoff device 21 with a collecting vessel 22 and, *via* lines 16 and 17, with a surge tank 18.

The apparatus shown in the drawing is operated, in accordance with the process of the invention, as described below.

Gasification residues produced in the gasification chamber 1 at pressures of, for example, 20 to 80 bar and at temperatures of 1100 to 1500°C drop into the water bath 2 where they are granulated and, while being suspended in the water, pass through a constantly open safety shutoff device 3, the flexible junction 4, e.g. a compensator an an open shutoff device 5 into the lock vessel 6 which is under the same pressure as the gasification chamber.

The water bath 2 has a high temperature of, for example, 180°C which is dependent on the water vapour partial pressure in the synthesis gas. To avoid the concentration of dissolved salts and fine-grained solid particles from the gasification residues in the water rising to an excessively high level, recycled water is constantly fed via the line 9 at a rate which is controllable by means of a valve 10. A liquid level controller 11 maintains the water level constant by actuation of a control device 12 in a discharge line 13. Very fine-grained residues having poor sedimentation behaviour may be withdrawn from the water bath 2 into the lock vessel 6 by means of the sucking action of an injector 7. The water withdrawn by the injector from the lock vessel is returned to the water bath 2 with the process waste water to function as driving medium for the injector 7.

As soon as the lock vessel 6 has been filled to the extent desired with the granulated residues or after the response of a filling level meter 14, the shutoff device 5 and, if necessary, a shutoff device 8 located before the injector 7 are closed and the lock vessel 6 is depressurized into the surge tank 18 via the line 16 and the by-pass line 17 by opening a pressure relief device 15. The surge tank is connected via a line 19 with a closed gas system which is maintained at a constant, slightly greater than atmospheric, pressure of, for example, 500 to 2000 mm water column or at atmospheric pressure.

After the pressure drop in the lock vessel 6 has been indicated by a pressure gauge 20, a shutoff device 21 opens the lock vessel so that the granulated residues can sink into the water-filled non-pressurized collecting vessel 22. As soon as the slag has emerged from the lock vessel, which may, if desired, be indicated by a second filling level meter 23, a larger amount of fresh water may flow from the surge tank 18 into the lock vessel 6 through line 16 by opening an inlet device 24 of large dimensions for a short period of time. Residual slag which may have been caught is thus flushed into the collecting vessel 22, the water of the lock vessel thereby being heated by the slag. It is also possible to open the inlet device 24 before the shutoff device 21 is opened so that the full flushing effect of the water emerging from the surge tank 18 is utilized for the discharge of fine-gasification residues having poorer sedimentation behaviour. The rapid sinking of the water level in the surge tank 18 additionally indicates that the lock vessel 6 is free from residues. The surge tank 18 is prevented from running empty by a level controller 29 which causes the shutoff device 21 to close. A filling level meter 25 at the top of the lock vessel 6 initiates alarm and shuts both shutoff devices 3 and 5 or blocks opening thereof if the water level in the lock vessel 6 drops in the event of trouble or disturbances. When the injector 7 is in operation, vapour is formed during the depressurization process by the hot water entering the lock vessel 6. In this case, the water level in the lock vessel 6 is kept constant by balancing the depressurization and the rate at which fresh water is supplied.

After sufficient fresh water has entered the lock vessel 6, the level controller 29 shuts the shutoff device 21. The pressure relief device 15 and the inlet device 24 are also shut. Pressure equalization of the lock vessel with the gasification chamber 1 is effected via a line 27 connected to the process water line 9 by opening a pressure equalization valve 26. A differential pressure meter 28 indicates pressure equalization.

By opening the shutoff device 5, granulated residues suspended in water re-enter the lock vessel 6 from the water bath 2.

The fresh water level in the surge tank 18, which has sunk is restored to its original height by opening a valve 30 in the feed line 31 in response to a further switching command from the level controller 29.

In the collecting vessel 22 which is at atmospheric pressure, the coarser slag particles introduced sink rapidly to the bottom while the settling velocity of the fine particles, which still contain carbon, is considerably lower. Therefore, these fine particles may be pumped off after a fixed period together with the excess water from the collecting vessel 22 by means of a waste water pump 32 and returned into the gasification process after passing a water treatment unit. The water level is again adjusted to the inital height by a level controller 33 by closing a shutoff device 34 in a discharge line 35. Only at this stage is the slag discharge device, which is a conventional type and not shown in the drawing, e.g. a mechanical slag scraper, started. Its conveying capacity is designed such that the slag is removed from the collecting vessel before the next discharge of the lock vessel.

Usually, the whole sluicing operation takes place automatically. Manual interventions are possible to prevent dangerous faulty switching.

The lock vessel 6 which is suspended by means of the flexible junction 4 at the pressure vessel enclosing the gasification chamber 1 can be moved, the pressure vessel in turn resting with a plurality of claws 36 in a supporting structure. The weight of all suspended structural parts is borne by springs 37 and, therefore, does not act on the parts 3, 4 and 5.

CLAIMS

1. A process for periodically sluicing residues produced by gasifying ash-containing fuel oxygen or one or more oxygen-containing compounds under a pressure of 100 to 200 bar, the gasification being carried out in a gasification chamber and the residues being granulated in a water bath in communication with the gasification chamber, the process comprising:

effecting pressure equalization between a lock vessel and the water bath and opening a connection between the water bath and the lock vessel to allow the residues to discharge from the water bath through the connection into the lock vessel;

closing the connection between the lock vessel and the water bath; opening a connection between the lock vessel and a surge tank to effect depressurization of the lock vessel and to effect removal of gases and steam via the surge tank to a closed gas system; opening a connection between the lock vessel and a collecting vessel to allow residues to pass from the lock vessel into the collecting vessel; and

allowing water to flow from the surge tank into the collecting vessel to flush suspended and granulated residues from the lock vessel into the collecting vessel; maintaining the water level in the collecting vessel when its connection with the lock vessel is open, sufficiently high to prevent gas entering the lock vessel from the collecting vessel; and removing the residues from the collecting vessel.

2. A process according to Claim 1, wherein at least fine-grained residues are conveyed from the water bath to the lock vessel, when the connection between the water bath and the lock vessel is open, by means of an injector.

3. A process according to Claim 1, substantially as described herein with reference to the accompanying drawing.

4. Apparatus for carrying out a process according to Claim 1, comprising: a gasification reactor providing a gasification chamber and a water bath immediately below the gasification chamber; means for supplying recycled water to the water bath; a lock vessel; means for opening and closing a connection between the water bath and the lock vessel; a collecting vessel; means for opening and closing a connection between the lock vessel and the collecting vessel; a surge tank; and means for opening and closing a connection between the lock vessel and the surge tank.

5. Apparatus according to Claim 4, wherein the connection between the water bath and the lock vessel comprises a flexible portion.

6. Apparatus according to either of Claims 4 and 5, further comprising a water jet injector arranged to be operated by recycled water supplied to the water bath.

7. Apparatus according to any of Claims 4 to 6, further comprising means for detecting the water level in the water bath and for controlling the water level in response to the detected level.

8. Apparatus according to any of Claims 4 to 7, further comprising means for detecting the level of residues in the lock vessel.

9. Apparatus according to any of Claims 4 to 8, wherein the lock vessel is provided with a pressure gauge.

10. Apparatus according to any of claims 4 to 9, further comprising means for detecting the level of water in the surge tank and for controlling supply of water to the surge tank in response to the detected level.

11. Apparatus according to Claim 5 or any of Claims 6 to 10 as appendent to Claim 5, wherein said flexible portion is an angular compensator.

12. Apparatus according to Claim 4, substantially as described herein with reference to and as illustrated in the accompanying drawing.

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